GDT 63

A. Scope

For a complete list of GDTs, see the Table of Contents.

This method serves as a rapid field-correlation test. The purpose of this method is to indicate, under standard conditions, the relative proportions of clay-like or plastic fines and dust in granular soils and fine aggregates that pass the No. 10 (2.00) mm sieve. The term "sand equivalent" expresses the concept that most granular soils and fine aggregates are mixtures of desirable coarse particles, sand, and generally undesirable clay or plastic fines and dust.

Referenced Documents

AASHTO Standards

M92 Wire-cloth Sieves for Testing Purposes

M231 Weighing Devices Used in the Testing of Materials

T 2 Methods of Sampling Aggregates

T 27 Method of Test for Sieve Analysis of Fine and Coarse Aggregates

T 248 Method of Test for Reducing Field Samples of Aggregate to Testing Size

B. Apparatus

1. Graduated Measuring Cylinder - Graduated measuring cylinder made of transparent acrylic plastic having an inside diameter of 1.2 in (30.75 mm), a height of 17.25 in (431.8 mm) with graduations up to 15 in (381 mm) by tenths of an inch (1mm) increments, beginning at the inside bottom, and a rubber stopper to fit in the mouth of the cylinder (WS-E-02).
2. Irrigator Tube - Irrigator tube made of 1/4 (6 mm) outside diameter stainless steel tubing with one end closed to form a wedge-shaped point. Drill a hole [drill size No. 60 (1.016 mm)] on each side of the wedge approximately 1/8 in (3 mm) from the tip. The angle of the holes should be between 30 and 50 degrees from the vertical (WS-E-07).
3. Siphon Assembly - A siphon assembly consisting of a 1 gal (3.785 L) bottle (WS-E-06), a 1/4 (6 mm) diameter copper bent tube 16 in (406.4 mm) long, 48 in (1219.2 mm) of 3/16 in (4.76 mm) inside diameter rubber tubing (WS-E-09) (pure gum or equal) with pinch clamp, a blow tube, 2 in (50 mm) of 1/4 in (6 mm) diameter copper tube, (50 mm) of 3/16 (4.76 mm) inside diameter rubber tube and a No. 6 rubber 2-hole stopper. In lieu of the specified plastic bottle, you may use a glass or plastic vat having a larger capacity, provided you maintain the liquid level of the working solution between 3 ft (0.9144 m) and 3.8 ft (1.1684 m) above the work surface.
4. Weighted Foot Assembly - Weighted foot assembly consisting of a 1/4 (6 mm) diameter brass rod 17.5 in (445 mm) long, threaded on both ends, a brass foot 1.187 in (30.15 mm) hex by 0.54 in (13.72 mm), a weight approximately 2 in (50 mm) by 2.078 in (52.78 mm) of cold-rolled steel, a sand reading indicator 1.13 in (28.7 mm) in diameter by 0.59 in (14.99 mm) made of Nylon 101, Type 66 Annealed. The top edge of the sand reading indicator shall be exactly 10.1 in (256.54 mm) from the bottom of the brass foot. The total weight of the assembly shall be 2.2 lbs ± 0.01 lbs (1000g ± 5 g).

NOTE: The older model weighted foot assembly has a guide cap that fits over the upper end of the graduated cylinder and centers the rod in the cylinder. The foot of the assembly has a conical upper surface and three centering screws to center it loosely in the cylinder. The older model does not have the sand reading indicator affixed to the rod, but a slot in the centering screws of the weighted foot is used to indicate the sand reading. You may use this weighted foot assembly if the newer model is not available.

5. Measuring Can - Measuring can, 3 oz ± 0.18 oz (85 ml ± 5 ml) capacity.
6. No. 10 (2.00 mm) Sieve - No. 10 (2.00 mm) sieve conforming to the requirements of AASHTO Designation M-92 .
7. Funnel - Funnel, wide mouth, for transferring soil into the cylinder.
8. Bottle - 1 gal (3.78 L) bottle to store the working solution.
9. Plastic Bag
10. Timing Clock - Timing clock or watch.
11. A Large Spoon—A large spoon with the sides bent in an approximate "V" shape.

- Materials
  1. Stock Solution—Make this solution by dissolving 1 lb (454 g) of calcium chloride in 1/2 gal (1.89 L) of distilled water. Cool and filter through ready-pleated rapid filtering filter paper. Add 4.5 lbs [2050 grams (1640 ml)] of USP glycerin and 1.7 oz [47 grams (45 ml)] of formaldehyde to the filtered solution, mix well and dilute to 1 gal (3.78 L).
  2. Working Solution—Dilute 1 measuring can full 3 oz (85 ml) of the stock solution to 1 gal (3.78 L) with distilled water. You may use demineralized or tap water of good quality, but compare results of the sand equivalent tests on identical samples using solutions made with the water in question and with the distilled water.

- Precautions
  1. Perform the test in a vibration-free location. Vibrations may cause the suspended material to settle at a faster rate, or may prevent settlement.
  2. Do not expose the plastic cylinders to direct sunlight any more than necessary.
  3. Occasionally you may need to remove a fungus growth from the working calcium chloride solution container and from the inside of the flexible tubing and irrigator tube. This fungus is easily detected as a slimy substance in the solution. To remove this growth, follow these steps:
     a. Prepare a cleaning solvent by diluting sodium hypochlorite (Clorox, or its equivalent, is satisfactory) with an equal quantity of water.
     b. Fill the solution container with the prepared solvent, allow about 1/4 gal (1 L) of the solvent to flow through the siphon assembly and irrigator tube.
     c. Close the pinch clamp on the end of the tubing to hold the solvent in the tube.
     d. Refill the container and allow to stand overnight.
     e. After this soaking, remove the solvent through the siphon assembly and irrigator tube.
     f. Remove the siphon assembly from the solution container and rinse both with clear water. Rinse the irrigator tube and siphon assembly by connecting a hose between the tip of the irrigator tube and a water faucet and backwash fresh water through the tube.
  4. Occasionally the holes in the tip of the irrigator tube may become clogged by a particle of sand. If the obstruction cannot be freed by less destructive methods, use a pin or other sharp object to force it out using extreme care not to enlarge the size of the opening.
  5. Perform this test with strict temperature control. The temperature of the water and working calcium chloride solution shall remain 72° ± 5°F (22° ± 3°C).

C. Sample Size and Preparation

1. Perform the sand equivalent test on soils or fine aggregate materials passing the No. 10 (2.00 mm) sieve. Perform the sieving on oven-dried material. Break down any lumps of finer material present in the original sample to pass the No.10 (2.00 mm) sieve by grinding with a rubber covered pestle or wooden mallet. Add the resulting fines to the sample.

NOTE: When running samples in the field for control purposes, you may run them damp, but they must not have free moisture present. Take extreme care to prevent the fines from being left stuck to the coarser particles when sieving over the No. 10 (2.00 mm) sieve. Results obtained with damp samples will almost always be lower, so if a sample fails when run damp, run it using oven-dried material.

2. The prepared sample shall be approximately 1.1 lbs (500 g). Put the material in a plastic bag (if available) and twist the end of the bag closed to trap air in the bag. Thoroughly mix the sample by holding the bag at both ends and vigorously shake it back and forth in an elliptical motion.

NOTE: If a plastic bag is not available, thoroughly mix the prepared sample in a flat bottom pan or bowl. Take care to prevent the sample from segregating or from losing fines.

3. Place the plastic bag on its side so you may scoop into the material with the large spoon that has been bent into an approximate "V" shape. Ensure that the sample for any one test is one measuring can full.

4. When filling the 3 oz (85 ml) cans, tap the bottom edge of the cans on the work table or other hard surface to consolidate the material and to allow more material to be placed in the cans. Fill the cans to the brim or give a slightly rounded surface above the brim, but do not overflow. Use extreme care in this procedure to obtain a truly representative sample.

D. Procedures

1. Place the 1 gal (3.78 L) bottle of the siphon assembly 3 ft ± 1 in (914.4 mm ± 25.4 mm) above the working surface. Start the siphon by blowing into the top of the solution bottle through the short piece of tubing while the pinch clamp is open. The apparatus is now ready to use.
2. Siphon the working solution into the plastic cylinder to a depth of 4 in ± 1 in (101.6 mm ± 25.4 mm).
3. Pour one measuring can full of the prepared sample into the plastic cylinder, using the funnel to avoid spillage. Tap the bottom of the cylinder firmly on the heel of the hand several times to dislodge any air bubbles and to aid in wetting the sample. Allow to stand for 10 minutes.
4. At the end of the 10 minute soaking period, stopper the cylinder then loosen the material from the bottom by tilting and simultaneously shaking the cylinder.
5. After loosening the material from the bottom of the cylinder, shake the cylinder and contents using the following method:
   a. Hold the cylinder in a horizontal position and shake it vigorously in a horizontal linear motion from end to end.
   b. Shake the cylinder 90 cycles in approximately 30 seconds, using a throw of 9 in ± 1 in (225 mm ± 25.4 mm). A cycle is a complete back and forth motion. To shake the cylinder properly at this speed, have the operator shake with forearms only, relaxing the body and shoulders.
6. Following the shaking operation, set the cylinder upright on the work table and remove the stopper.
7. Insert the irrigator tube in the cylinder and rinse material from the cylinder walls as the irrigator tube is lowered. Force the irrigator tube through the material to the bottom of the cylinder by applying a gentle stabbing and twisting action, while the working solution flows from the irrigator tip. This flushes the fine material into the suspension above the coarser sand particles. Continue to apply a stabbing and twisting action while flushing the fines upward until the cylinder is filled to the 15 in (381 mm) mark.
8. Raise the irrigator tube slowly without shutting off the flow so that the liquid level is maintained at approximately 15 in (381 mm) while the irrigator tube is being withdrawn. Regulate the flow just before the irrigator tube is entirely withdrawn and adjust the final level to 15 in (381 mm).
9. Allow the cylinder and contents to stand undisturbed for 20 minutes ±15 seconds. Start timing immediately after withdrawal of the irrigator tube is complete.
10. At the end of the 20-minute sedimentation period, read and record the level of the top of the clay suspension on the graduated cylinder. This is the "clay reading." If no clear line of demarcation has formed at the end of the specified 20-minute sedimentation period, allow the sample to stand undisturbed until a clay reading can be obtained. Then immediately read and record the level of the clay suspension and the total sedimentation time. If the total sedimentation time exceeds 30 minutes, rerun the test 2 times using 2 individual samples of the same material. Read and record the clay column height of that sample requiring the shortest sedimentation period only. If clay or sand readings fall between the 0.1 in (2.54 mm) graduation, record the level of the higher graduation as the reading. For example, a clay level at 7.95 in (201.93 mm) is recorded as 8.0 in (202 mm). A sand level at 3.22 in (81.788 mm) is recorded at 3.3 in (81.8 mm).
11. When using the weighted foot assembly having the sand reading indicator on the rod of the assembly, place the assembly over the cylinder and gently lower the assembly toward the sand. Do not allow the indicator to hit the mouth of the cylinder as the assembly is being lowered. As the weighted foot comes to rest on the sand, tip the assembly toward the graduations on the cylinder until the indicator touches the inside of the cylinder. Subtract 10 in (254 mm) from the level indicated by the extreme top edge of the indicator and record this value as the "sand reading."
12. If using an older model weighted foot assembly having centering screws, keep one of the centering screws in contact with the cylinder wall near the graduation so you can see it at all times while the assembly is being lowered. When the weighted foot has come to rest on the sand, read the level of the centering screw and record this value as the "sand reading."

13. To empty the cylinder, insert the stopper and shake the cylinder up and down in an inverted position until the sand plug is disintegrated. Empty immediately and rinse twice with water.
14. Perform the sand equivalent test twice. If the results are within 4 points of each other, report the average. Variances of more than 4 points between results indicate too much error in operator procedure or sample selection. In such cases, run a third test and average the 2 closest results (within 4 points of each other) using the method shown in the calculations below. Report the results.

E. Calculations

1. Calculate the sand equivalent (SE) to the nearest 0.1 using the following formula:

   $$SE = \frac{Sr}{Cr} \times 100$$

   Sr = Sand reading

   Cr = Clay reading

2. When the result of this calculation is not a whole number, the sand equivalent (SE) shall be the next higher whole number as in the example below.
3. To determine the sand equivalent (SE) for a material after performing the series of tests called for in Procedures, 14 above on the material, average the sand equivalents from the two tests selected. The sand equivalent value shall be that average raised to the next higher whole number when the result of this calculation is not a whole number as in the example below:

   $$\text{If SE values} = 41 \text{ and } 42, \text{ average SE} = \frac{41+42}{2} = 41.5 = 42$$

F. Report

The average sand equivalent shall be reported as in the example below:

SE= 42